Nematology Circular No. 141
May 1987

Fla. Dept. Agric. & Consumer Serv.
Division of Plant Industry

# RED RING NEMATODE

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Red ring nematode (RRN), Rhadinaphelenchus cocophilus (Cobb, 1919) J. B. Goodey, 1960, is one of the principal tropical nematode pests that could become established in Florida and cause serious damage to coconut and some other palms. It infects coconut palms in Yucatan, just across the Gulf of Mexico from Florida, and is also established in many Caribbean islands and tropical countries that use Florida as a gateway to the United States. The large palm weevil, Rhynchophorus palmarum, harbors and vectors red ring nematodes and is a constant threat as an infected hitchhiker on the numerous planes and vessels that enter Florida each week.

ECONOMICS: Millions of people in the world are directly or indirectly dependent on coconut palms for a living and more than 8 million acres of coconut palms are grown. Millions of dollars are lost annually as a consequence of the disease, in addition to the time and cost of wasted cultivation. In 1923, 2000 acres of coconut plantations were abandoned because of red ring disease. In a 10 year period Venezuela lost 35% of its oil palms. In Grenada, 22.3% of the coconut palms were found infected with RRN. A total of 92% of the infected trees were invaded by the palm weevil vector, and 72% of the weevils were infected with RRN. In the last few years, crop losses induced by the nematode in many countries averaged from 10-15% of the total coconut production or higher.

GEOGRAPHIC DISTRIBUTION: Barbados, Belize, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, San Blas Islands, St. Vincent, Surinam, Tobago, Trinidad, and Venezuela.

HOST LIST: Acromia aculeata, A. intumescens, Attalea sp., Cocos nucifera, Elaeis guineensis, Mauritia flexuosa, M. mexicana, Maximiliana maripa, Oenocarpus distichus, Phoenix canariensis, P. dactylifera, Roystonea oleracea, and R. regia.

SYMPTOMS: Young palms between 3-7 years old are attacked more frequently than older ones; however, palms 15-20 years old sometimes are attacked and succumb to the disease. Leaves infected with RRN become discolored and acquire a yellow-bronze hue which turns to deep reddish brown. Typically, this color change begins at the leaf tip and continues progressively towards the leaf base, also from tips of the leaflets towards the rachis. Leaves wilt, die, and bend downwards, folding themselves along the side of the palm (Fig. 2). Fruits fall prematurely. It is generally reported that RRN does not invade inflorescences and fruit, but in Venezuela, on rare occasions, nematodes do invade the inflorescence and can be found in the milk of immature fruit. If roots are infected, they may sometimes turn dark yellow or reddish brown in color.

When the palm is cut crosswise, healthy palms appear creamy white on the cut face (Fig. 1-A); the cut face of diseased palms have a distinct, circular, red band, approximately 3-5 cm in width (Fig. 1-B). The color of this ring may vary from light pink to dark brown, although the most frequent color is a bright shade of red, from which the disease derives its name. Occasionally atypical rings may be found which consist of small dots of discolored tissue throughout the central portion of the cut. RRN is not found in the first 3-5 cm from the trunk periphery, but it does occupy the entire central portion of tissue. In a longitudinal cut, a pair of reddish colored, parallel bands will be observed. These bands can extend the entire length of the trunk or occupy only a portion of it, either from the crown downward or from the base upwards towards the top. Cut fronds of infected palms frequently exhibit a red crescent or ring mottling at the base. Infected oil palms exhibit the coloration on the cut face as a heart-shaped pattern (Fig. 1-C).

Young trees die within 6-8 weeks, but older ones may last 16-20 weeks after symptoms appear. In certain areas, infected palms live several years. Internal symptoms are present before external ones, and symptom expression may vary among different geographical regions.

PATHOGENICITY: In a Venezuelan plantation, over one-half of 24 coconut and 24 ten-year old oil palms became infected. After one and one-half years most of the trees in the plantation were dead or dying.

In Trinidad, twenty-four 4-7 year old coconut palms inoculated with RRN showed damage 14-21 days later. Also, twenty-four 4-7 year old coconut palms inoculated with RRN in the roots, 20 cm from the bole, developed symptoms and died within 60 days.

DISSEMINATION: RRN principally reach noninfected palm trees in or on the bodies or feces of the palm weevil. They also may be carried on seeds, seedlings, tools, vehicles, animals, or move by natural migration from infected to noninfected roots. Wood chippings from axes or machetes used to fell infected palms, as well as the felled infected palms themselves, also serve as infective material. Fifty of 105 palms exposed to dropped infected chips become infected 5-25 weeks later. RRN survived 16 weeks in nut

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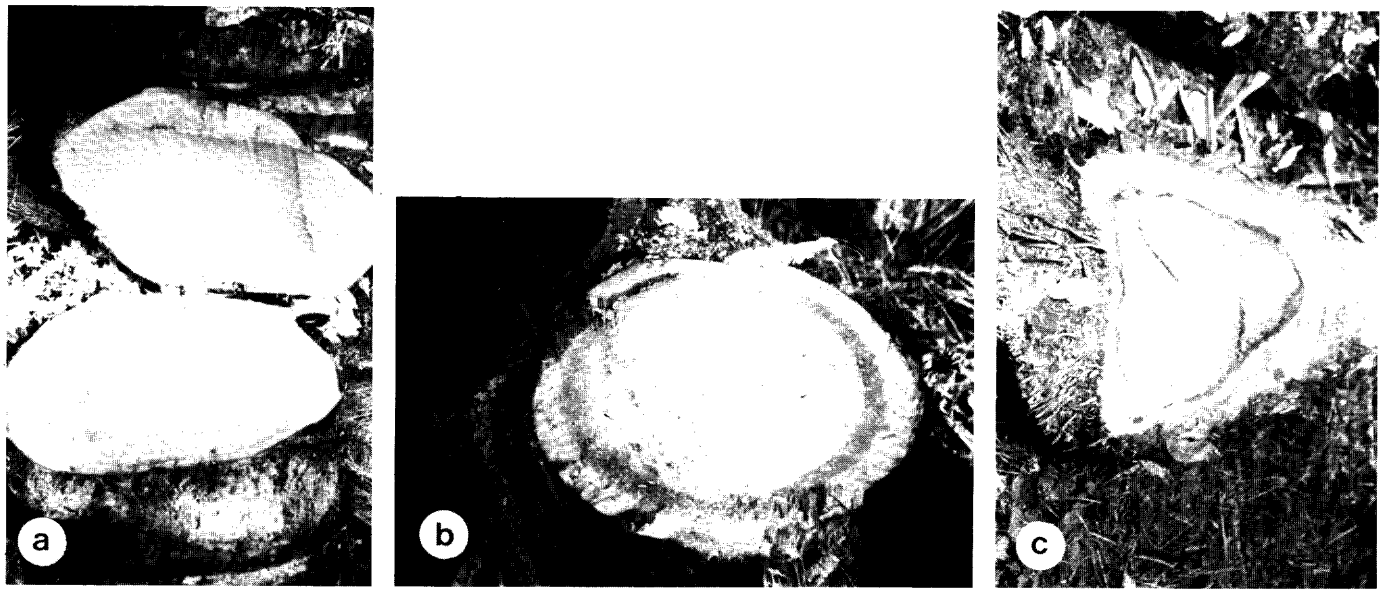


Fig. 1. Trunk symptoms. Coconut palm: A. healthy; B. diseased.
Oil palm: C. diseased.

Fig. 2. Young coconut palm in late stages of disease.

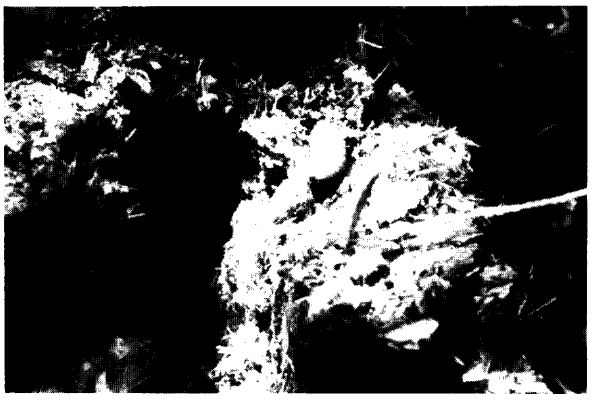

Fig. 3. Vector larva in coconut palm frass.

Fig. 4. Weevil trapping site.

husks, and 90 weeks in infected seedling tissue. These nematodes are reported to move 5.6 mm/hr in soil and up to 41 mm/week in roots.

ATTRACTION: Weevils infested with RRN are attracted to palms by the putrid odor emanating from freshly cut or wounded palm tissues, as well as the fermentation odor of diseased tissue. Inside the palm, high concentrations of carbon dioxide attract RRN to its preferred feeding site.

INFECTION OF PALMS: Coconut palms 4-10 years old are most susceptible, whereas oil palms are generally infected at a more mature age. Incidence of infection is correlated with the seasonal occurrence of the palm weevil, and a new cycle of infection is initiated about every 90 days. Weevil populations are favored by heavy rainfall. The most frequent sites of RRN infection are cracks formed in the palm leaf axils by wind and leaf weight engendered stress. Infection sites are also found in stem wounds, root wounds or cracks, and weevil feeding sites. During the day, weevils are sheltered in leaf axils where particles of infested debris or feces fall. The nematode also migrates from the weevil body to feeding sites if conditions are favorable for its survival.

DENSITY: Ten grams of infected coconut palm tissue yielded 108,000 RRN, while 10 grams of oil palm tissue yielded 50,000 RRN. It is not unusual to find more than 10,000 nematodes per gram of infected tissue.

HOST PARASITE RELATIONSHIP: Xylem vessels in infected areas are occluded with tyloses which inhibit water transport in the palm. Coconut palms with RRN have been shown to absorb less water than healthy palms. Inside the palm, RRN feeds in the thin-walled vascular parenchyma cells in the red colored area of stems and extends into the entire central portion of the palm. The nematode also feeds in vascular parenchyma cells in petioles and in the root cortex.

LIFE CYCLE: The life cycle of RRN reared on harvested immature nut tissue was 9-10 days.

SURVIVAL: RRN does not survive in soil for more than 2-3 days, but it lives in decomposing tissue of dead palms up to 90 days. Inside its weevil vector, RRN can survive 10 days, while on the body of its vector, it can survive only 2-3 days. Live RRN were recovered from decaying roots a year after removal of the top portion of the palm.

VECTORS: The principal vector of RRN is Rhynchophorus palmarum. The following are also reported as vectors of RRN: Ants, spiders, and Coptotermes niver, Dinamis politus, Hemiphileuris sp., Hololepta sp., Homalinatus coriaceus, Leucotermes tenius, Metamasius hemipterus, Nasutitermes ephratae, Parisoschenus obesulus, Rhinostomus barbirostris, and Strategus aloeus.

INFECTION OF WEEVILS: Weevil larvae become contaminated with RRN from infected frass in the tunnels of the palm stems (Fig. 3), and weevils emerging from pupae may be infected with massive numbers of RRN. Virgin weevils may have RRN in their feces. In Trinidad, weevils are present in 2 discrete sizes. Large weevils lay 200-400 eggs and are usually free of RRN while small weevils lay 0-50 eggs and are usually infected with RRN. Small weevils are used as a positive index in forecasting red ring disease outbreaks. Too many RRN in the vector haemocoel can be fatal to the vector.

HABITAT: Highest incidence of the disease occurs in low, poorly drained areas. RRN are susceptible to desiccation, and drought conditions keep the disease in check. RRN survive best in wet, swampy areas. In clay soil, 50 of 105 palms inoculated with RRN became infected, while in sandy soil only 12 of 105 inoculated palms became infected.

SURVEY: Look for 4-10 year old palms with red ring disease symptoms, then cut into the lower stem or bore into the stem with an increment borer. The infection should be verified by laboratory analysis for RRN. To survey for infected weevils, cut down a 4-10 year old palm with symptoms, leaving the cut faces exposed. Cover the exposed faces with fronds from the felled palm (Fig. 4) since open sun inhibits weevil visits. After 24 hours return to the site and collect weevils on or near the cut faces.

REFERENCES: These data are represented by 397 references filed in the Bureau of Nematology data retrieval system under 33-A Bibliography.

1. Dean, C. G. 1979. Red ring disease of Cocos nucifera L. caused by Rhadinaphelenchus cocophilus (Cobb, 1919) Goodey, 1960, an annotated bibliography and review. Techn. Communication No. 47 of Commonwealth Inst. Helminthol., st. Albans, England.
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Contribution No. 323, Bureau of Nematology

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